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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,695	03/30/2001	Si Yi Li	015290-500	4162

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EXAMINER	
OLSEN, ALLAN W	
ART UNIT	PAPER NUMBER
1763	

DATE MAILED: 10/25/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/820,695	LI ET AL.	
	Examiner	Art Unit	
	Allan Olsen	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 May 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,7,9,10,12-17,19-25 and 27-30* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,7,9,10,12-17,19-25 and 27-30* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *01 June 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 9, 10, 12, 13, 19, 20, 27, 29 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh in view of US Patent 6,159,792 issued to Kim et al. (hereinafter, Kim).

Hsieh teaches etching a carbon-doped, low-k dielectric layer on a semiconductor substrate. Hsieh teaches using an etchant consisting of C_xF_y, NH_3 and Ar (abstract). Hsieh teaches that C_xF_y may be C_5F_8 (column 4, line 9). Hsieh teaches an etchant having a C: N atomic ratio of 0.3:1 which, when using C_5F_8 is satisfied with a C_5F_8 flow rate that is 6% of the NH_3 flow rate (column 3, line 65- column 4, line 2). Hsieh teaches achieving an etch selectivity of at least 5 with respect to the overlying mask (column 5, lines 48-52). Hsieh teaches supplying the C_xF_y and the NH_3 at flow rates within the claimed ranges (column 4, lines 37-39). Hsieh teaches applying bias power to the substrate and maintaining the chamber pressure and substrate temperature within the claimed range (column 4, line, 45 and column 5, ~line 25). Hsieh teaches a dual

frequency parallel plate plasma reactor with showerhead electrode and a bottom electrode on which the substrate is supported (column 3, lines 36-45).

Hsieh does not teach using N_2 and therefore does not teach an etchant consisting essentially of C_5F_8, N_2 and Ar. Hsieh does not teach what material underlies the oxide.

Kim teaches etching an oxide with an etchant consisting of C_5F_8, N_2 and Ar or C_5F_8, NH_3 and Ar (column 3, lines 60-66).

It would have been obvious to one skilled in the art to replace the C_5F_8/ NH_3/ Ar etchant of Hsieh with the C_5F_8/ N_2/ Ar etchant of Kim because Kim teaches that because teaches the functional equivalence of these two etchant mixtures. It would have been obvious to one skilled in the art to apply the method of Hsieh to structures with the claimed underlying material because the claimed material corresponds to that which typically underlies a low-k dielectric. On this point the examiner takes Official Notice.

Claims 2, 3, 7, 14-17, 21 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh in view of Kim, as applied to claim 1 above, and further in view of US Patent 6,455,411 issued to Jiang et al. (hereinafter, Jiang).

The combination of Hsieh and Kim does not teach etching the low-k dielectric in the context of a dual damascene process wherein a 0.25 μ opening, with an aspect ratio of 5:1, is etched into a dielectric layer that has an overlying and underlying layer of silicon nitride or carbide, and in which the opening is subsequently filled with metal.

Jiang teaches a process of etching a carbon doped low-k dielectric in the context of a dual damascene process is etched into a dielectric layer that has an overlying and

underlying layer of silicon nitride or carbide, and in which the opening is subsequently filled with metal. See figure 2 and column 2, line 48 - column 3, line 15.

It would have been obvious to one skilled in the art to combine Hsieh and Jiang because Hsieh's disclosure pertains to etching a low-k dielectric layer but Hsieh's disclosure is generic with respect to the context in which the dielectric layer placed and Jiang teaches etching a similar dielectric layer and that this dielectric has utility in the context of a dual damascene process.

It would have been obvious to one skilled in the art to apply the combined teaching of Hsieh and Jiang to a process of etching of 0.25 μ features with a 5:1 aspect ratio because Jiang teaches etching a contact hole to a depth of 10,500 and the industry standard for the size of contact holes at the time of Hsieh's and Jiang's disclosures was 0.2 microns or less and this size opening in combination with an etching depth of 10,500 angstroms corresponds to a 5:1 aspect ratio.

Claims 22, 23, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent 6,753,263 issued to Ito et al. (hereinafter, Ito).

Ito teaches etching a carbon doped low-k dielectric below a Si_3N_4 (see, for example, figures 4-7). Ito teaches a SiO_3 to Si_3N_4 selectivity of greater than 5 (see Table 1, column 9). Ito teaches an etchant comprising C_4F_8 and a lesser amount of CH_2F_2 (see figure 8). Ito teaches adding N_2 to the etchant (column 5, line 60; column 15, line 60).

Ito does not teach that the total C_4F_8 and CF_2H_2 flow rate is 30% or less than the N_2 flow rate.

It would have been obvious to one skilled in the art to use a total C_4F_8 and CF_2H_2 flow rate that is 30% or less than the N_2 flow rate because Ito discusses the addition of

N_2 within the context of including additives such as Ar and Ito teaches using a very large excess of Ar. Furthermore, it is considered obvious to optimize the process conditions such as flow rates.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of US Patent 6,184,119 issued to Ku et al (hereinafter, Ku).

The above noted teaching of is herein relied upon.

Ito does not teach using a dual frequency reactor.

Ku teaches using a dual frequency reactor.

It would have been obvious to one skilled in the art to use the dual frequency reactor of Ku because Ku states; "a dual-frequency driven plasma source ...can achieve high etch selectivity of SiO_2-to-Si_3N_4" (column 1, lines 34-38).

Response to Arguments

Applicant's arguments, filed August 10, 2006, with respect to the rejection under 35 USC 102 have been fully considered and are persuasive. Therefore this rejection has been withdrawn.

Applicant's arguments with respect to the rejections under 35 USC 103 have been fully considered but they are not persuasive. With respect to the rejection of claim 18 (now cancelled and incorporated into claim 1), applicant argues that the references do not teach that a $C_5F_8/N_2/Ar$ mixture and a $C_5F_8/NH_3/Ar$ mixture are functionally equivalent with respect to oxide etching, as suggested by the examiner. Applicant argues "that the two etchants are not disclosed by Kim as being functionally equivalent and the references also provide no motivation or suggestion of modifying Hsieh as

proposed in the Official Action." Applicant argues that NH_3 and N_2 are not recognized as being functionally equivalent because Hsieh teaches that NH_3 function to clean up deposited polymer on the photoresist surface and on process chamber surfaces whereas Kim teaches N_2 or NH_3 can be added to a fluorine etchant to increase the etch rate between the interlayer insulating layer and the underlying stop layer.

In response, the examiner notes that applicant's arguments contain contradictions. One the one hand applicant states "that the two etchants are not disclosed by Kim as being functionally equivalent" while on the other hand applicant cites Kim's teaching from column 3, line 65 wherein Kim teaches the functional equivalence by stating, "N_2 or NH_3 is added in the fluorine etchant".

Secondly, with respect to the applicant's argument that the references provide no motivation or suggestion of modifying Hsieh as proposed in the Official Action, the examiner notes that substitution of equivalents requires no express motivation as long as the prior art recognizes the equivalency.[1]

With respect to applicant's argument that Hsieh and Kim teach N_2 and NH_3 function differently and therefore are not recognized as being functionally equivalent, the examiner notes that Kim expressly teaches that $C_5F_8/N_2/Ar$ and $C_5F_8/NH_3/Ar$ <u>are</u> functionally equivalent with respect to etching an oxide layer. The fact that Hsieh notes a particular attribute of using N_2 while Kim recognizes additional attributes as a result of using either N_2 or NH_3 does support the position that N_2 and NH_3 are not recognized as equivalents when Kim expressly teaches that either $C_5F_8/N_2/Ar$ or $C_5F_8/NH_3/Ar$ can be used to etch oxide. Regarding applicant's argument that Hsieh teaches NH_3 functions

[1] *In re Fount* 213 USPQ 532 (CCPA 1982); *In re Siebentritt* 152 USPQ 618 (CCPA 1967); *Graver Tank & Mfg. Co. Inc. v. Linde Air Products Co.* 85 USPQ 328 (USSC 1950).

as a cleaning agent, it is noted that Kim teaches a process that can proceed without a cleaning process after an oxide etch that uses, for example $C_5F_8/N_2/Ar$ or $C_5F_8/NH_3/Ar$ (column 2, lines 9-13; column 3, line 23). The examiner notes two additional teachings of Hsieh that would further lead one skilled in the art to have a reasonable expectation of success upon substituting NH_3 with Kim's N_2. First, a substitution of NH_3 with N_2 would concur a loss of hydrogen from the plasma environment; however, Hsieh teaches that the oxide layer being etched is itself a source of hydrogen (column 3, lines 60-64). Secondly, it is noted that when discussing the flow ratio between NH_3 and C_5F_8, Hsieh teaches that it is the carbon to nitrogen ratio that is important (column 3, line 64 - column 4, line 5).

With respect to independent claim 22, rejected under 35 USC 103 as being unpatentable over Ito, applicant argues that Ito fails to disclose an etch selectivity of at least 5 between an oxide and on overlying mask. Applicant argues Ito teaches an etch selectivity between an oxide and an underlying stop layer rather than an overlying mask.

The examiner notes that the structure being etched by Ito comprises an oxide/nitride/oxide configuration. Ito teaches the lower 204 oxide and the upper oxide 208 are of the same material. With respect to the etching of via 210, nitride layer 206 serves as an etchstop by masking the lower portion of oxide. When the etch of via 210 extends below the upper surface of nitride layer 206 Ito's process comprises the claimed process of etching a low-k dielectric layer with selectivity to an overlying mask layer.

Regarding claim 28, applicant argues that Ito fails to teach that the low-k dielectric is a carbon-doped glass. However, Applicant points out that Ito teaches that

the oxide may be TEOS or a spin-on-glass. Oxides derived from TEOS are inherently doped with carbon. (See, for example, Hsieh, column 1, lines 25-30).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. The examiner can normally be reached on M, W and F: 1-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Allan Olsen
Primary Examiner
Art Unit 1763